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Development of Extreme Wildland Fire Recovery Chronosequences for the Northern Rockies, U.S.

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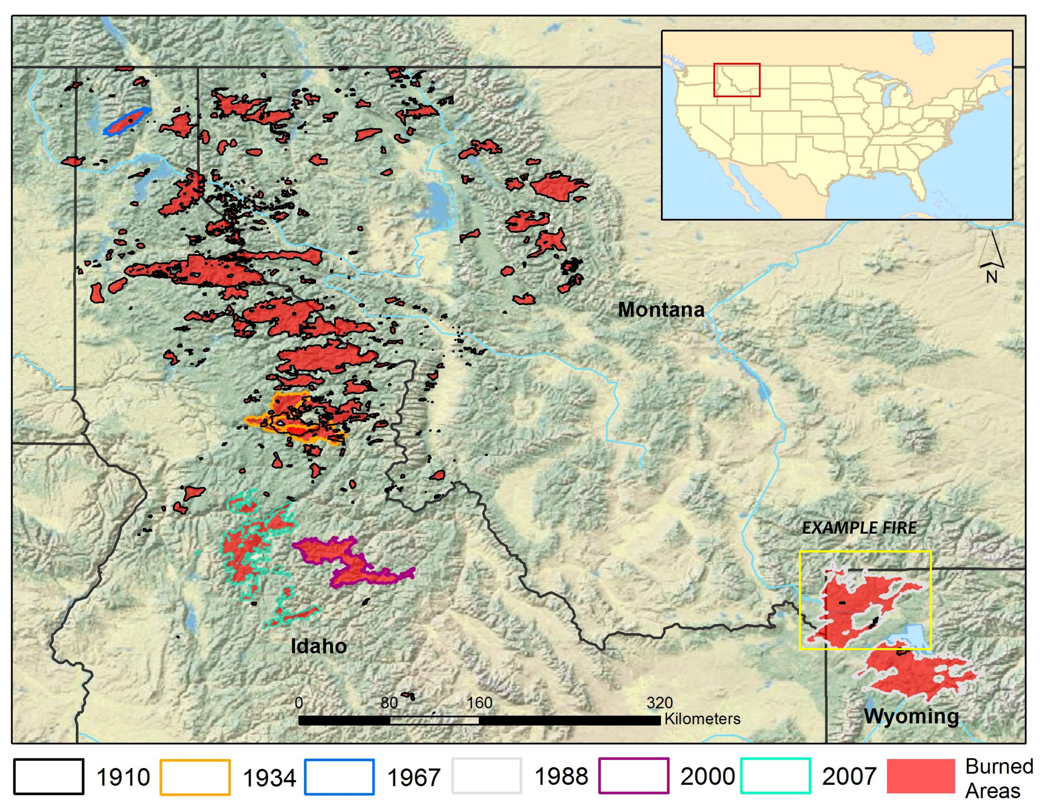
INTRODUCTION

In order to predict ecological and social recovery from extreme wildland fires under future climate scenarios, datasets are needed that cover the extended temporal range over which climate effects are observed (i.e. 50-100 years). *We explore the utility of developing an Extreme Wildland Fire Recovery Chronosequences for the Northern Rockies, by evaluating data from six historically extreme wildland fire events from 1910-2007, representative of forest ecosystems.* The fires selected represented outliers of what would be considered normal wildland fires, either because of their extreme size or fire behavior. The fires selected for analysis included fires from 1910, 1934, 1967, 1988, 2000, and 2007. Using a combination of historical fire atlas data, Monitoring Trends in Burn Severity (MTBS) fire perimeter data, and Landsat satellite imagery, post-fire vegetation indices will be calculated for all fires using archival imagery dating back to 1984. Each fire provides a snapshot in time of post-fire recovery (75-100, 50-75, 17-32, 0-25, 0-12, and 0-5 years post-fire), and will be combined to build a fire recovery chronosequence.

METHODS

To develop a 100 year+ chronosequence of post-fire recovery, several examples of extreme fires from the past 100 years were identified. Ideally fires are spaced out by 20 year intervals to get full coverage of the analysis time frame. Six fires have been selected to date.



Project Area: Northern Rocky Mountains, U.S.A.

The 1910 Fires - 1,736 fires burned more than 12,240 sq km of private and federal land, at least 85 peopled killed.

1934 Selway Forest Fires - 1,020 sq km burned, with extreme rates of spread (1-day period of 1798 ha per hour; 3-day period 6000 ha per day).

1967 Sundance Fire - Although the smallest of the fires used for this analysis (22,396 ha), an extreme rate of spread was reported - 20,234 ha in 9 hours.

1988 Yellowstone Fires - 4,900 sq km burned, of which 3,200 sq km was within the Yellowstone National Park (36% of the park).

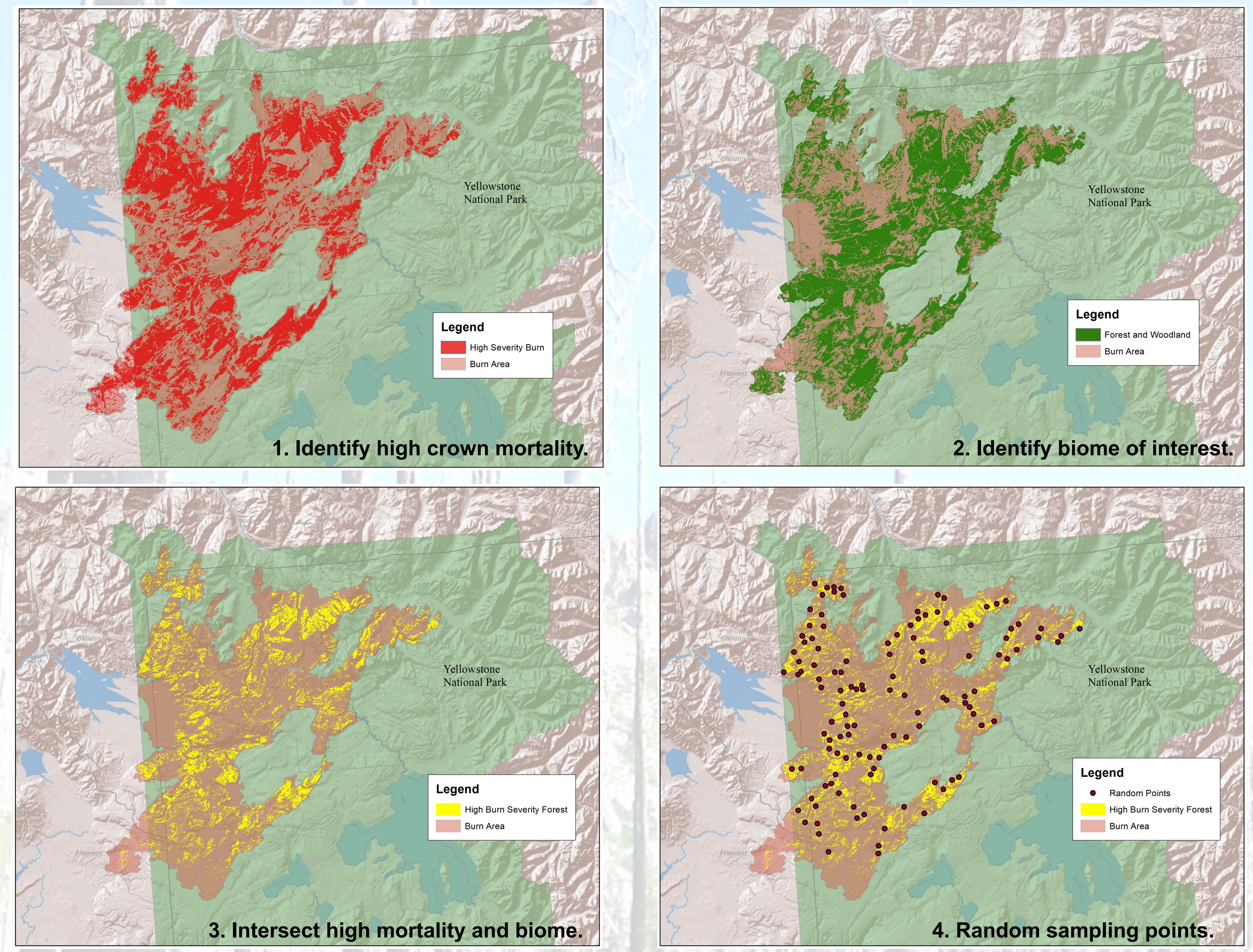
2000 (Diamond Complex) and 2007 (East Zone Complex and Cascade Complex) fires of Idaho - burned 3,096 sq km.

Historical fire atlas data and Monitoring Trends in Burn Severity (MTBS) data were used to identify burn perimeters of the selected extreme fires. Within these fire perimeters, areas were identified that have not re-burnt before (within the historical record) or after the extreme fire event and are in protected/wilderness areas (i.e. no or limited management actions). Initial analysis will evaluate areas in forest and woodland systems; although ultimately a wide range of ecosystems will be explored. Landsat data (1984-present) is being downloaded for all years available post-fire, during growing season months (May-August) for all six fires. The best scenes (cloud-free, snow-free) will be identified for each year and vegetation indices will be derived (with standard pre-processing, including dark body subtraction). Indices values will be extracted and averaged at 100+ random locations within fire boundaries. Each fire will provide a "snapshot" of vegetation recovery post-fire from which a level 1 product that does not account for climate will be derived.

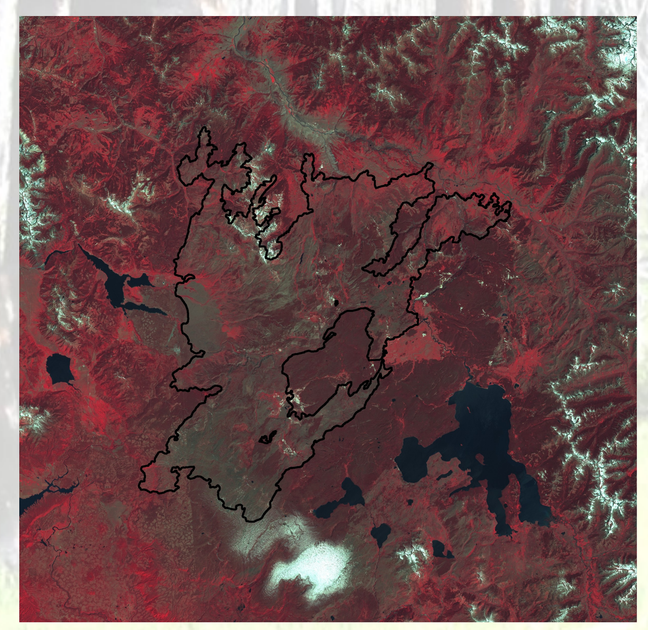
Table 1. Examples of historically large or socially impactful wildfires in the United States of America and their estimated impacts (various sources: Pyne, 1995; Arno and Allison-Bunnell, 2002; http://www.nps.gov/fire; http://www.nifc.gov/)

Fire Name	Size	Deaths	Recorded Social Impacts / Fire Behavior
1825 Miramichi and Maine Fires	12,140 km^2	160-300	Destroyed several communities
1845 Great Fire of Oregon	6,070 km^2		
1871 Peshtigo Fire of Wisconsin and Michigan	4,856 km^2	1182	
1871 Fires of Lower Michigan	10,117 km^2	200	Destroyed 3000 buildings
1881 Thumb Fire of Michigan	4,000 km^2	282	1520 home destroyed; fire travelled 20 miles in less than 2 hours
1894 Hinkley Fire of Minnesota	647 km^2	418	Destroyed town of Hinkley, Minnesota
1902 Yacoult Fire of Washington	> 4,046 km^2		
1910 Fires of Idaho and Montana	12,140 km^2	86	
1918 Cloquet Fire of Minnesota	4,856 km^2	450	Destroyed 38 communities
1988 Yellowstone Fires	5,700 km^2	0	$3 million of property damage
1997 Inowak Fire of Alaska	2,468 km^2		
2002 Biscuit Fire of Oregon	2,021 km^2		
2002 Rodeo-Chediski of Arizona	1,897 km^2		8,000 people evacuated, Destroyed 426 homes, suppression cost of $153 million
2004 Boundary Fire of Alaska	2,173 km^2		
2011 Wallow Fire of Arizona and New Mexico	2,177 km^2		72 buildings destroyed

Example: 1988 North Fork Fire



1. Identify high crown mortality.
2. Identify biome of interest.
3. Intersect high mortality and biome.
4. Random sampling points.

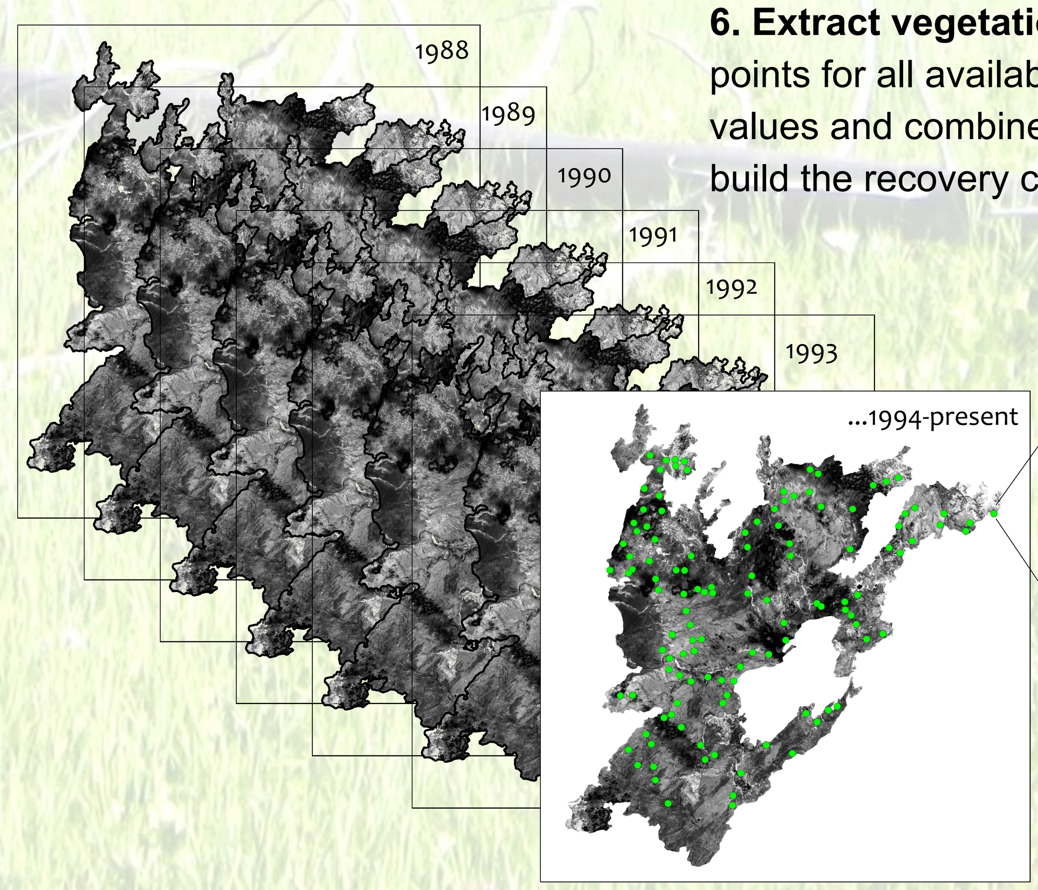


5. Download and process archival pre- and post-fire Landsat TM. Generate vegetation indices, for each scene. Multiple vegetation indices will be evaluated to determine the most useful index.

Vegetation Indices are algorithms used to extract from remotely sensed data canopy characteristics like biomass, productivity (phytomass), leaf area index (LAI), amount of photosynthetically active radiation (PAR) consumed, and percent vegetative ground cover (Larsson, 1993). An example of a vegetation index is ***NDVI.***

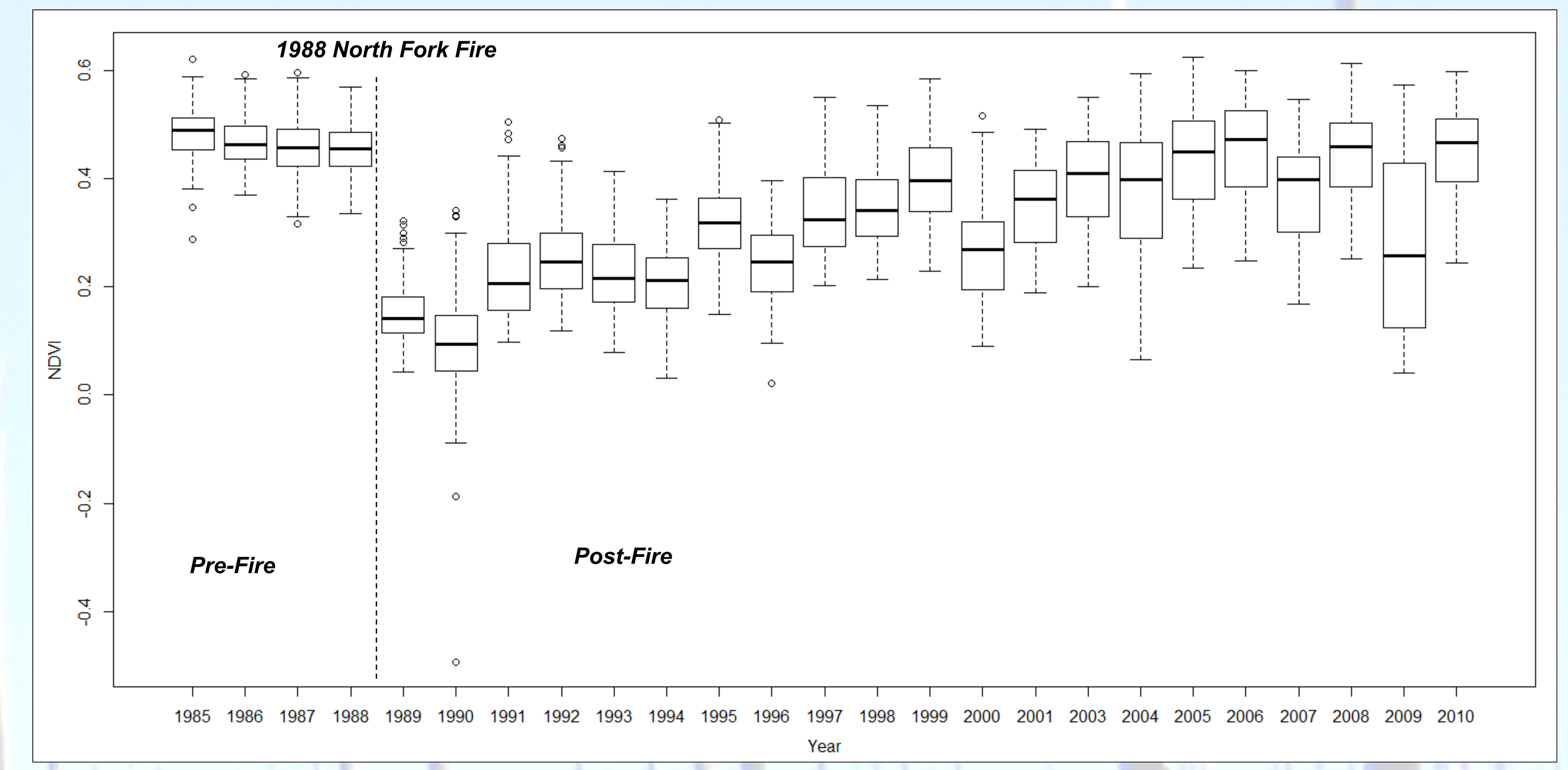
$$NDVI_{TM} = \frac{TM4 - TM3}{TM4 + TM3}$$

6. Extract vegetation indices values from sample points for all available years, pre- and post-fire. Plot values and combine points from multiple fires to build the recovery chronosequence.

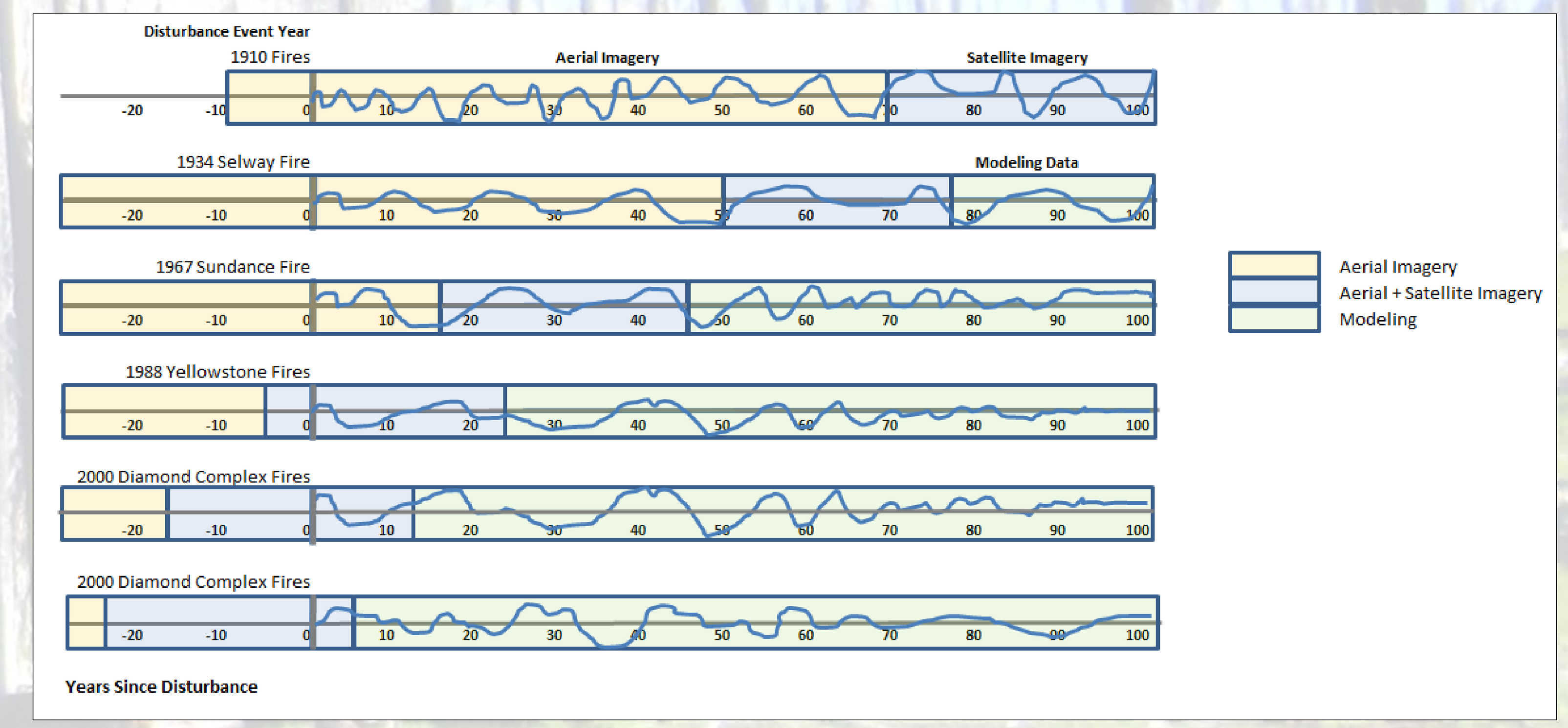


YEAR	NDVI
1985	0.55659
1986	0.48452
1987	0.51068
1988	0.46427
1989	0.0917
1990	0.13806
1991	0.16948
1992	0.26659
1993	0.23882
1994	0.05768
1995	0.32114
1996	0.24334
1997	0.32102
1998	0.33999
1999	0.34863
2000	0.32207
2001	0.31147
2002	0.31501
2003	0.39722
2004	0.44935
2005	0.43341
2006	0.32872
2007	0.45117
2008	0.45885
2009	0.44184

INITIAL RESULTS



NDVI values show a post-fire recovery increase in NDVI values. The same methodology will be repeated with the remaining five fires and post-fire NDVI recovery plots will be stitched together to create a 100-year recovery chronosequence



FUTURE DIRECTIONS

Future work will include field validation of the spectral index trajectories and the variation of those index values within different fires. Once the chronosequence is developed using common spectral indices related to vegetation condition, social metrics as defined through expert panels and surveys (and their changes over time) will also be investigated.

ACKNOWLEDGEMENTS

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REFERENCES

- Arno SF, Allison-Bunnell S (2002) Flames in our forest: disaster or renewal? Island Press, Washington, DC, USA.
- Larsson, H (1993) Linear regressions for canopy cover estimation in Acacia woodlands using Landsat-TM, -MSS, and SPOT HRV XS data. *International Journal of Remote Sensing* **14**, 2129-2136.
- Pyne SJ (1995) World Fire: The Culture of Fire on Earth. ISBN:0295-97593-8, Henry Hold and Company, Ind., New York, USA.

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